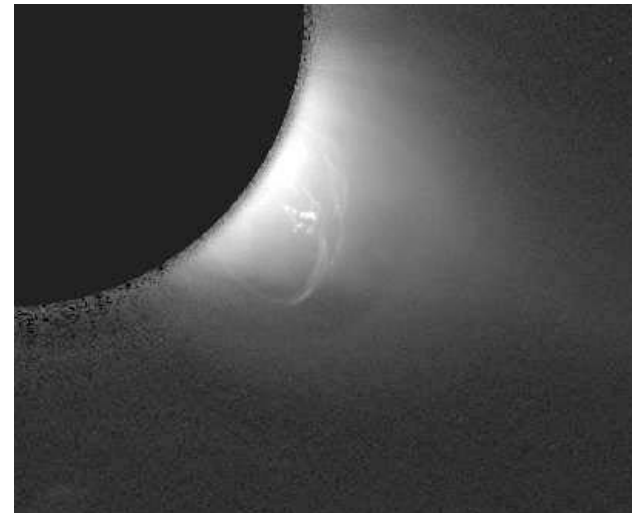
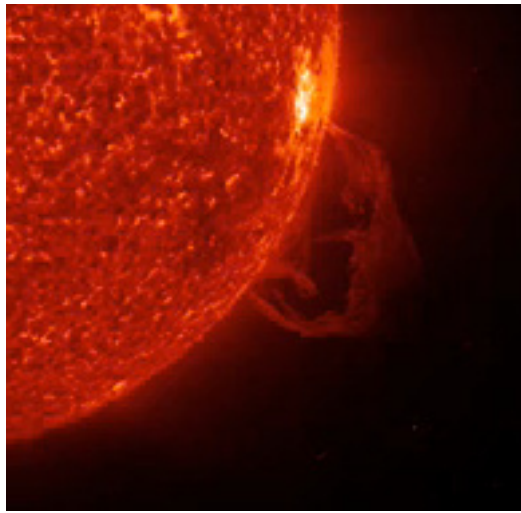


Stereoscopic Analysis of 19 May and 31 Aug 2007 Filament Eruptions



*P. C. Liewer, E. M. DeJong, J. R. Hall, JPL/Caltech;
R. A. Howard, NRL; W. Thompson, GSFC;
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Outline

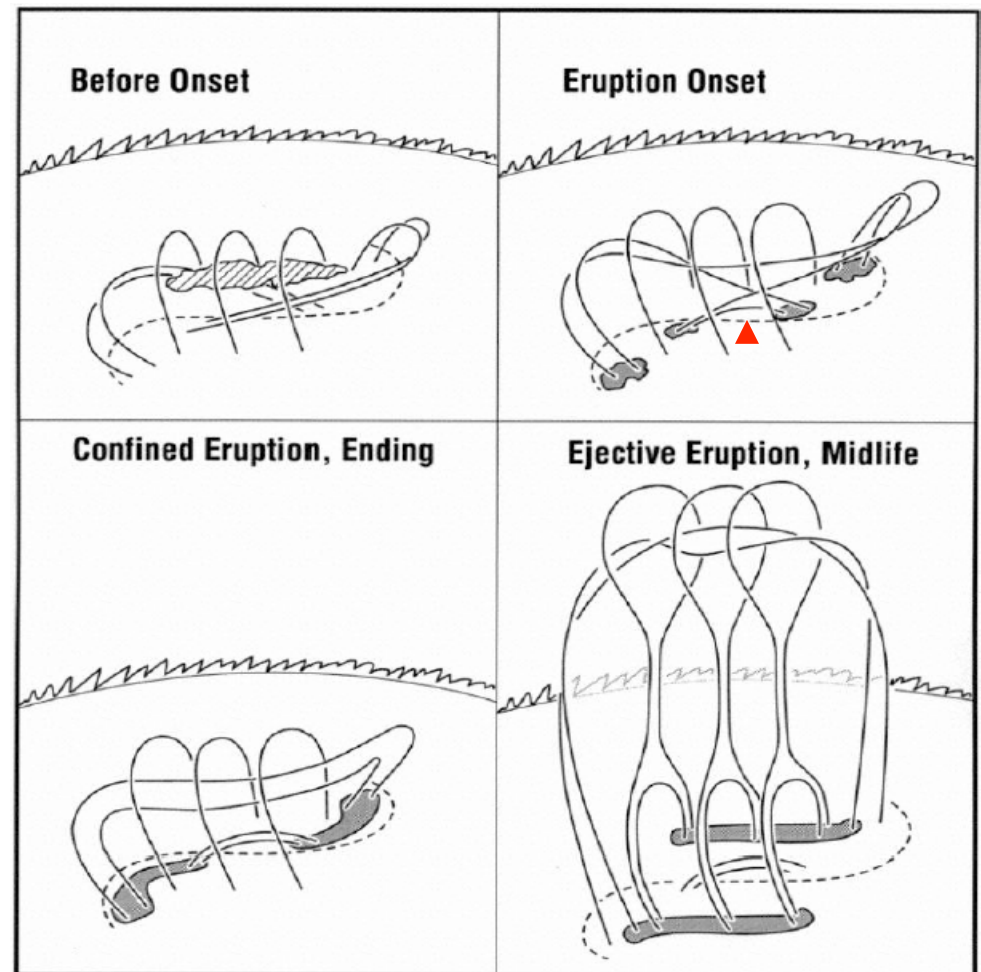
- Results from stereoscopic analysis of SECCHI/EUVI data for 19 May 2007 filament eruption:
 - Determined 3D trajectory of erupting filament
 - Strong evidence for reconnection BELOW erupting filament, consistent with standard model
 - Compare of EUVI and $H\alpha$ images during eruption
- Results from stereoscopic analysis of 31 August 2007 filament eruption:
 - Can track three features: filament, dark cavity & CME leading edge



Standard Model of Filament Eruption

- **Before Onset:** Filament marks location of highly sheared magnetic field crossing a neutral line (“filament channel”)
- **Onset:** Reconnection (\blacktriangle) of highly sheared field lines leads to less sheared field lines, changing connection of “filament” to surface
- **Confined Eruption:** “surges”, “activation” and “rising”
- **Ejective Eruption** and post-eruptive arcade and flare ribbons on either side of filament channel/neutral line
- **19 May 2007 filament shows all this and MORE**

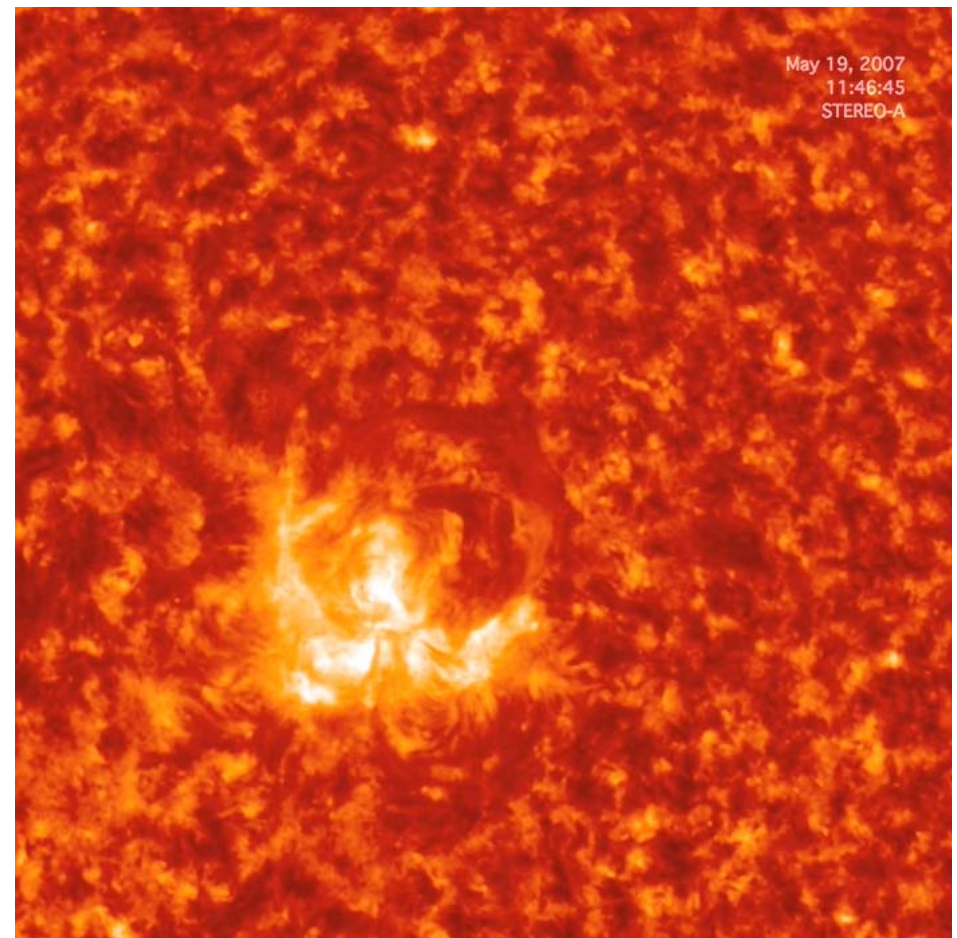
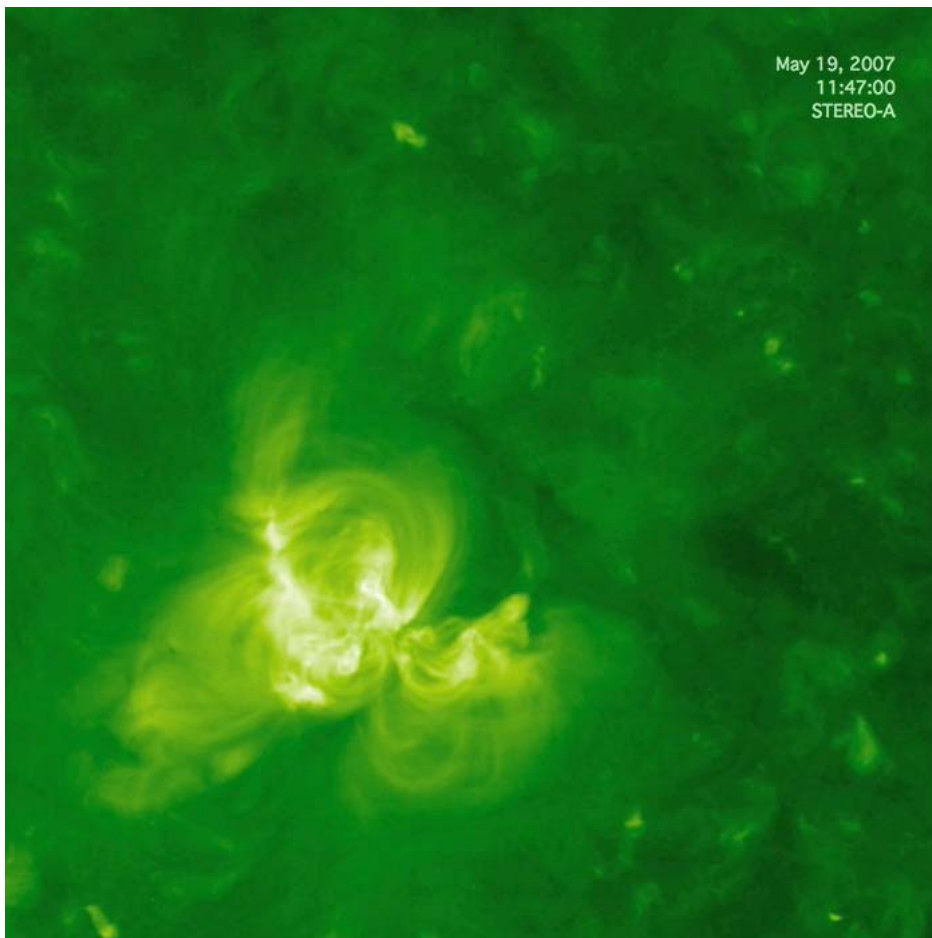
From Moore, Sterling, Suess; ApJ 2007



Not shown: Overlying magnetic arcade that becomes the CME

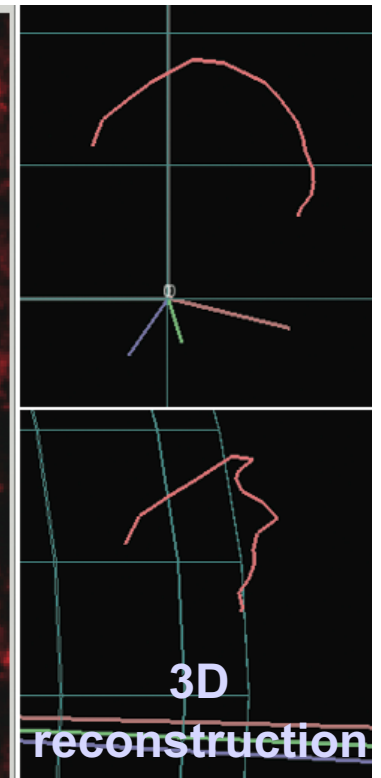
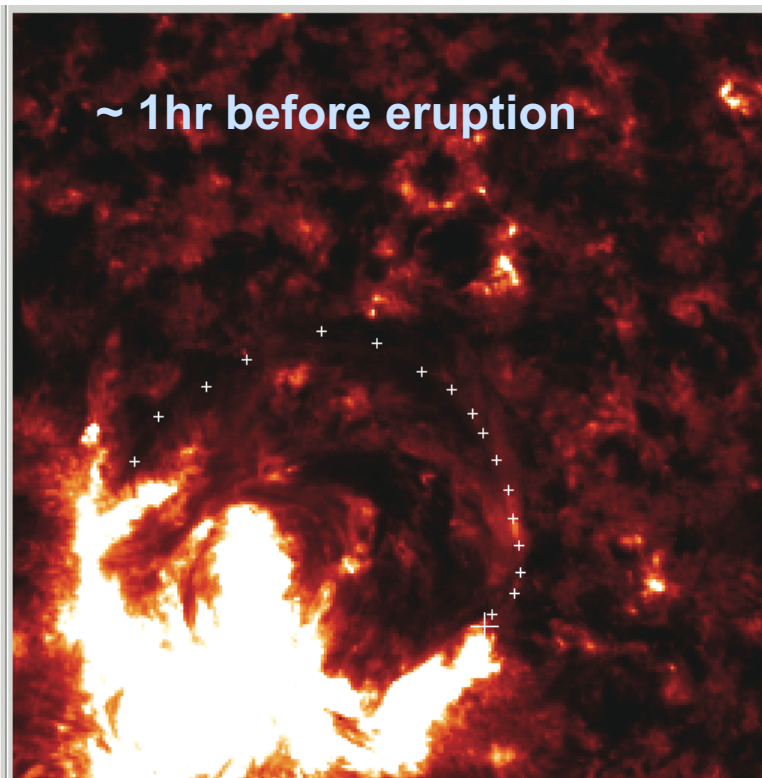
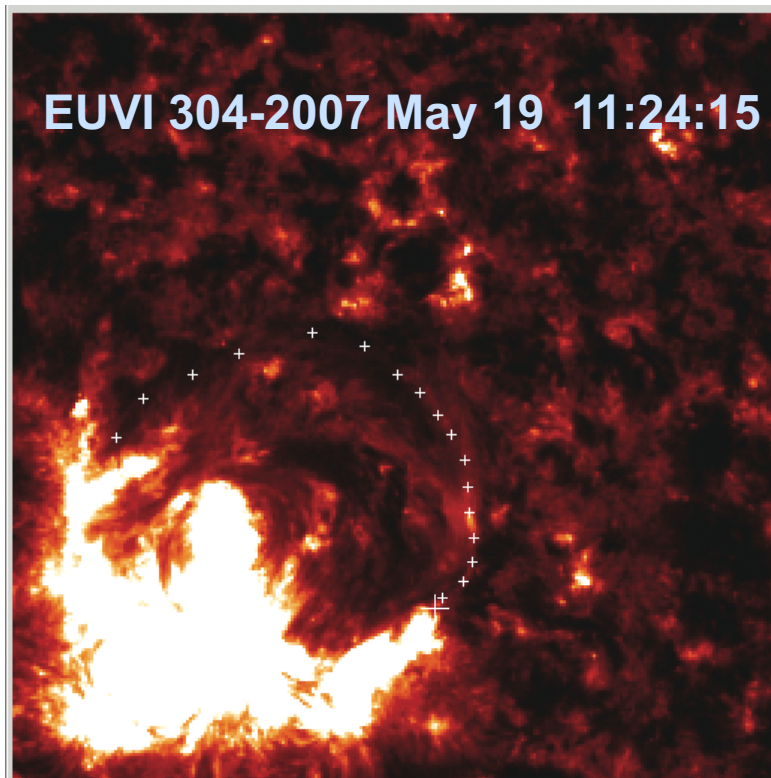
2007 May 19 STEREO A/SECCHI/ EUVI 195&304 A: CME Signatures & Filament Eruption

- 195A Movie shows flare, dimming, EIT wave and post eruptive flare arcade
- 304A Movie shows filament eruption, flare ribbons & ejection of filament material.



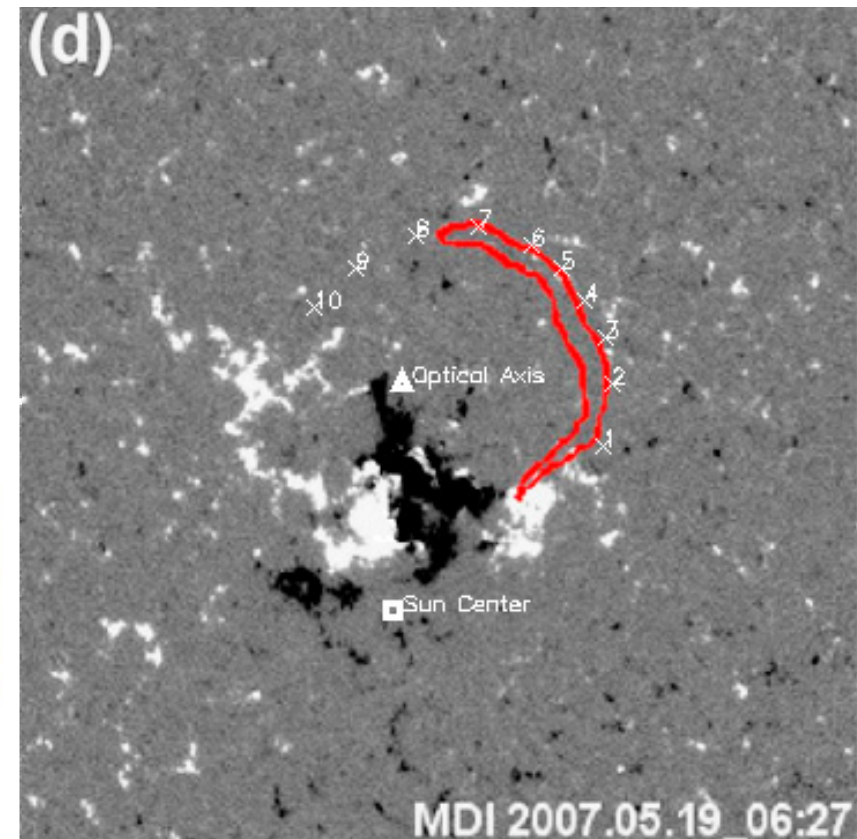
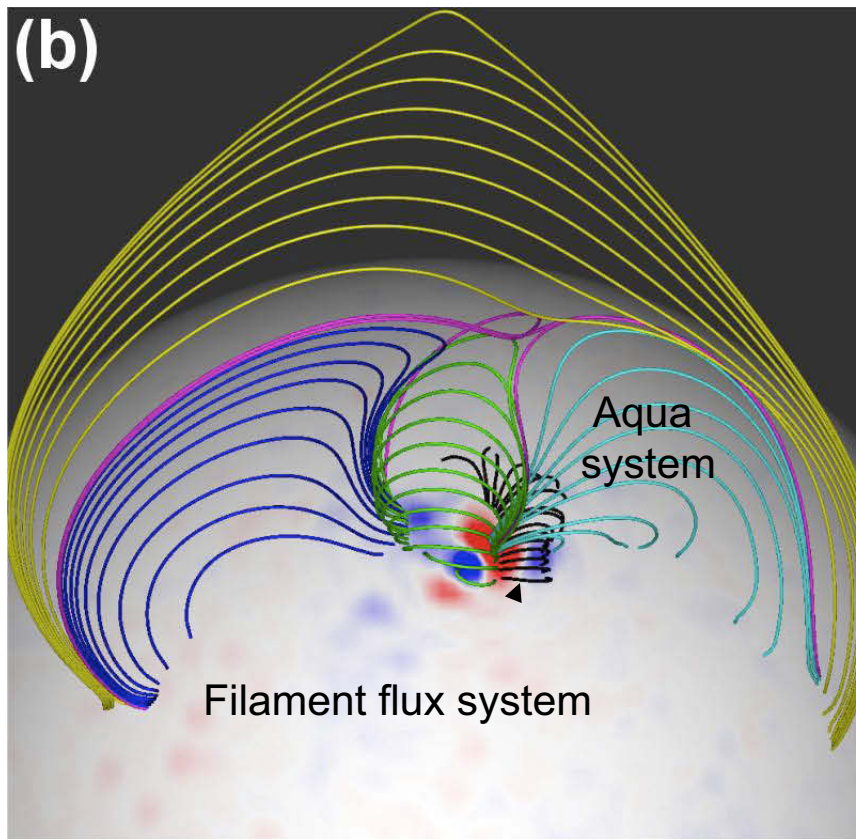
3D Reconstruction of Erupting Prominence

- Prominence visible in STEREO/EUVI data for ~25 hrs prior to eruption
- Reconstructed 3D prominence at ~20 times using simultaneous AB Pairs
 - ~8.5° separation of STEREO A&B in mid May 2007
- User marks same features on filament in both images of EUVI 304 AB pair
 - Tiepoints are constrained to lie in epipolar line
 - Limited by ability to identify same feature in both (A&B) images
- Triangulation program finds 3D coordinates in heliocentric system



Filament's Relation to Coronal Magnetic Fields

- Left** - PFSS Coronal Magnetic Field - black is filament's flux system;
 Aqua flux system (dimming region): must also open to let filament out
- Right** - MDI magnetogram showing filament's location relative to AR;
 $H\alpha$ (red) and EUVI 304 A (numbered white X's)
Full extent of filament best seen in EUV 304 A

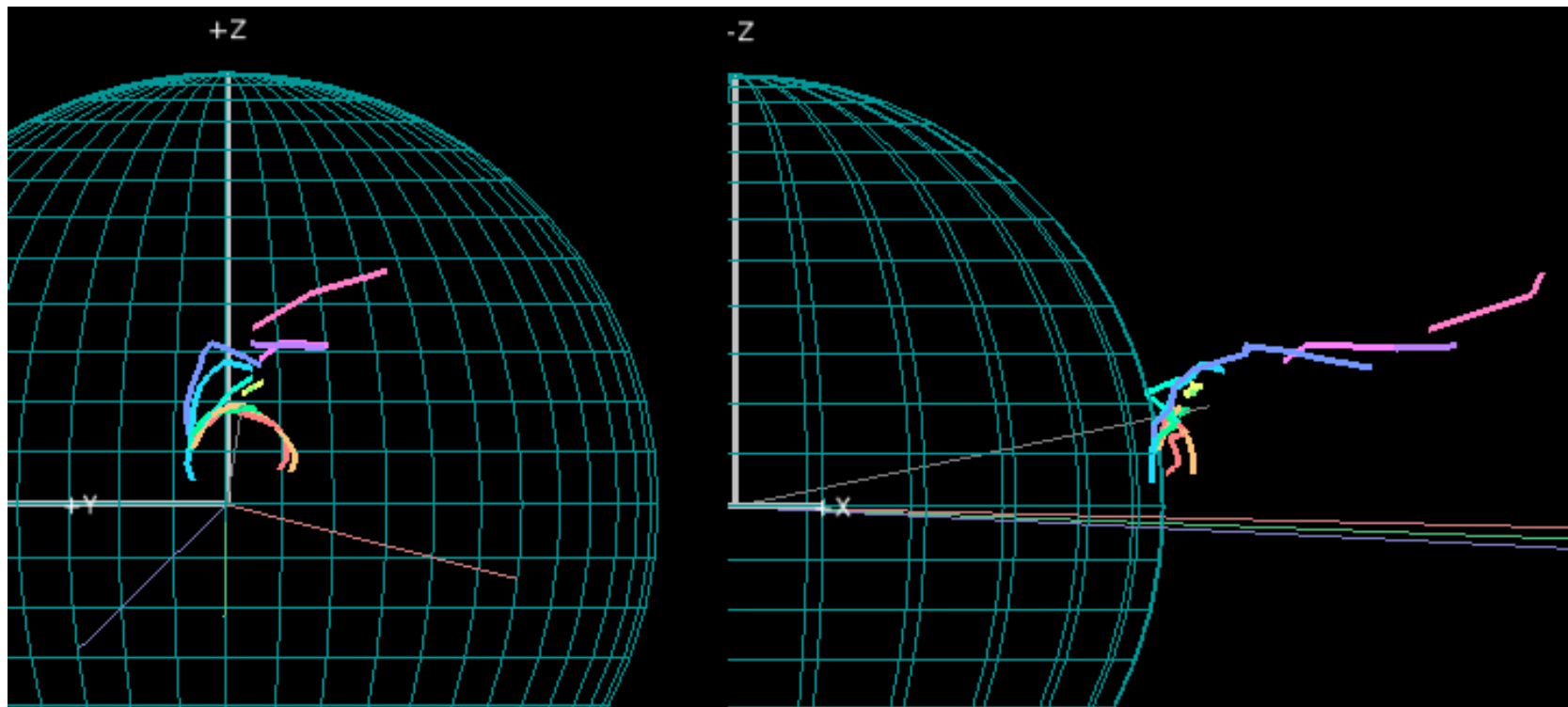


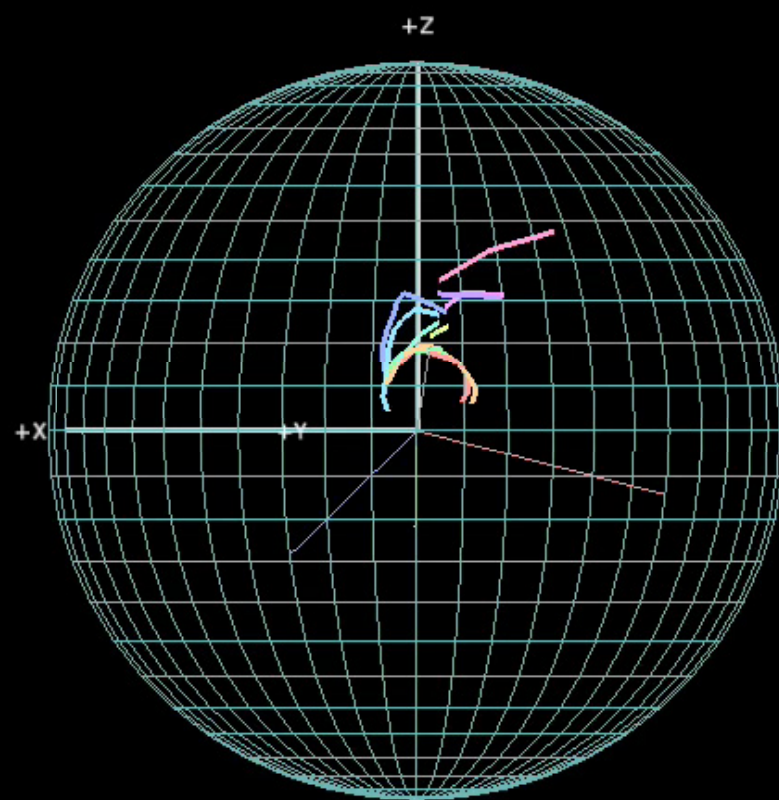
(from Li et al, Ap J Lett, to be published)

3D Reconstructions of Filament Eruption

Each colored segment represents a 3D reconstruction at one time before or during the eruption

- *Segments formed by connecting reconstructed points - NOT a fit to the points*
- ***Observe a single whip-like filament eruption starting at AR end***



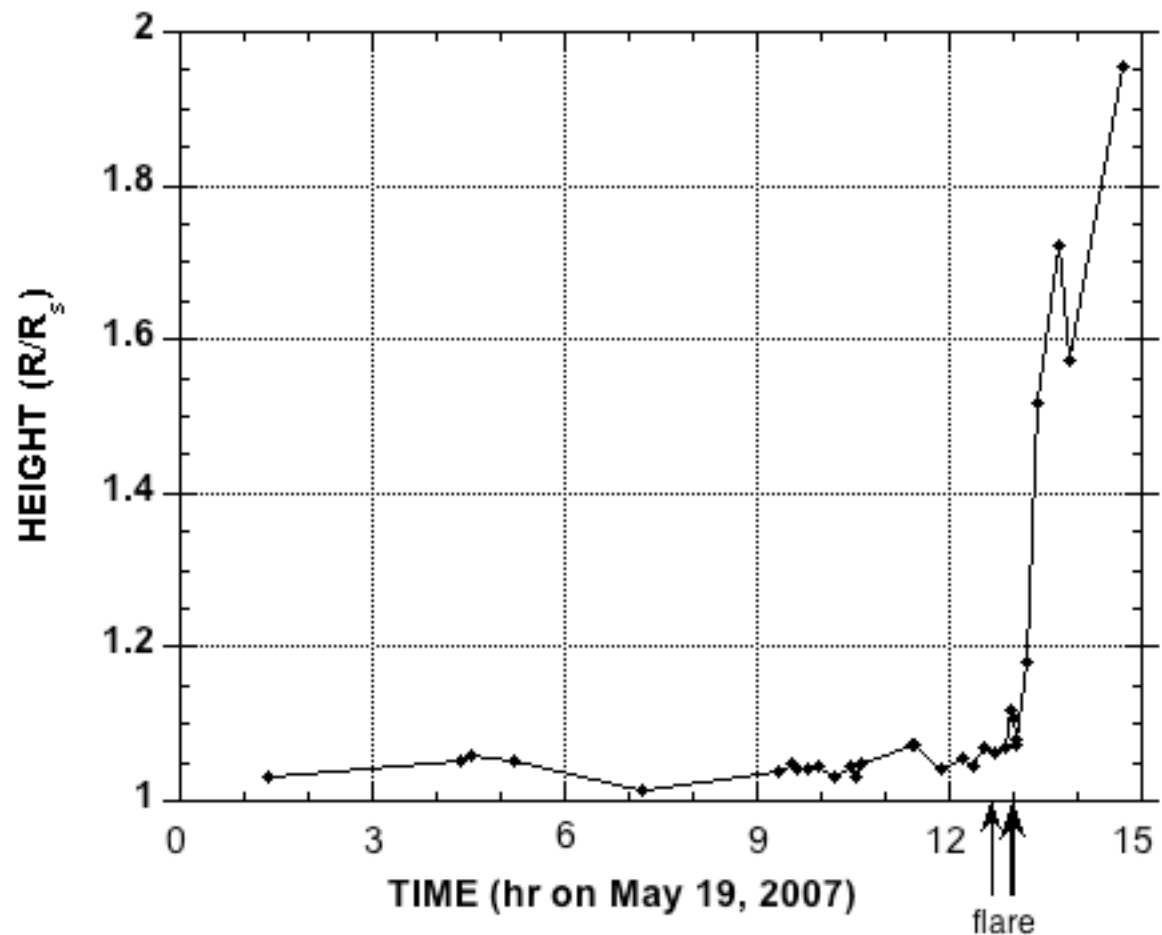


Height-Time Plot of Eruption from 3D Reconstructions

Filament ejection follows flare/reconnection, consistent with standard model

Velocity ~ 100 km/s much slower than associated CMEs
(see Kilpua et al, *Sol Phys* 2008)

Slight evidence of a slow rise phase before, but other surges/ activations also seen (confined eruptions of Moore et al 2007)

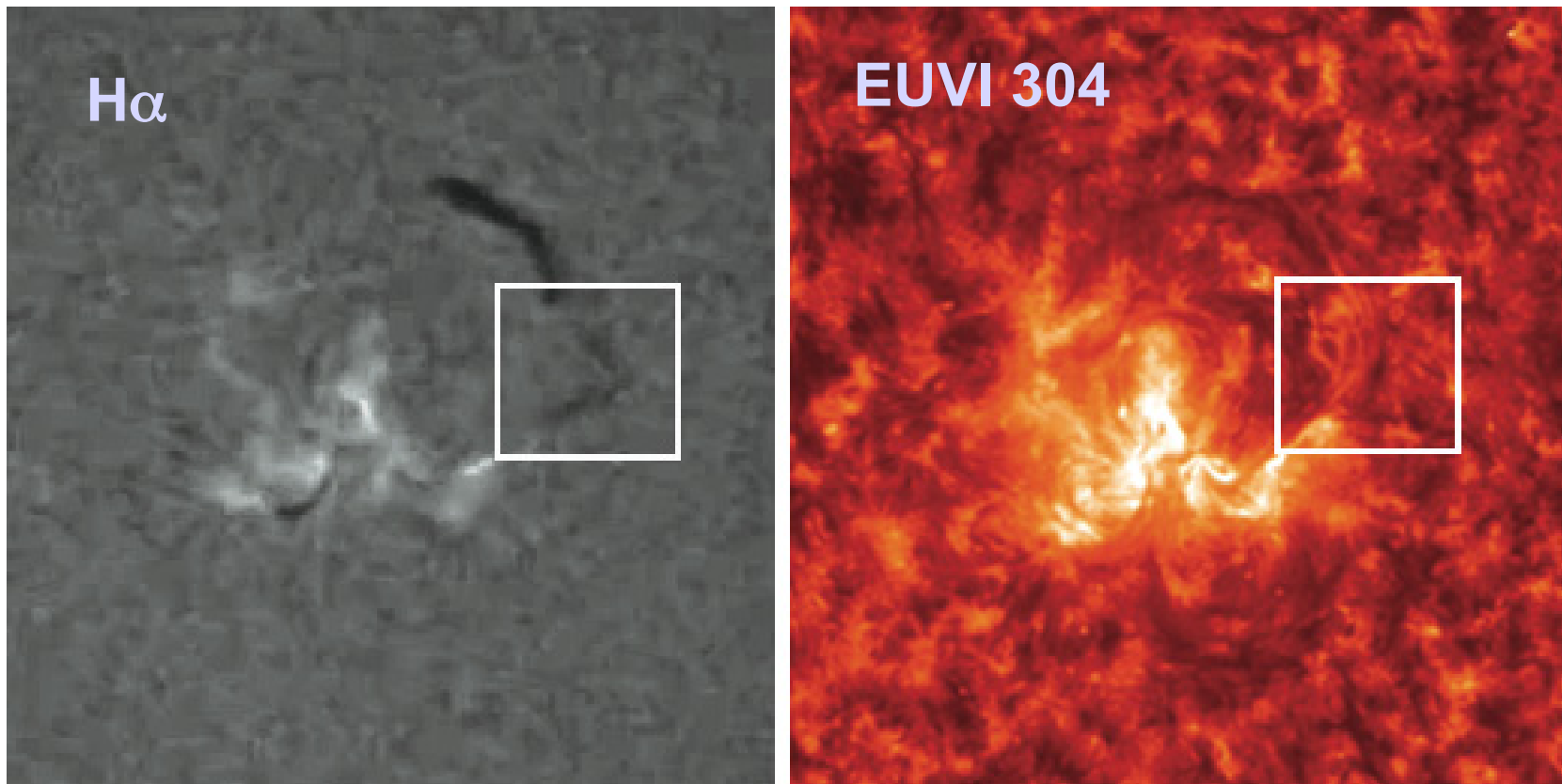


Flare start* Flare peak
12:48

*also ribbons in H α

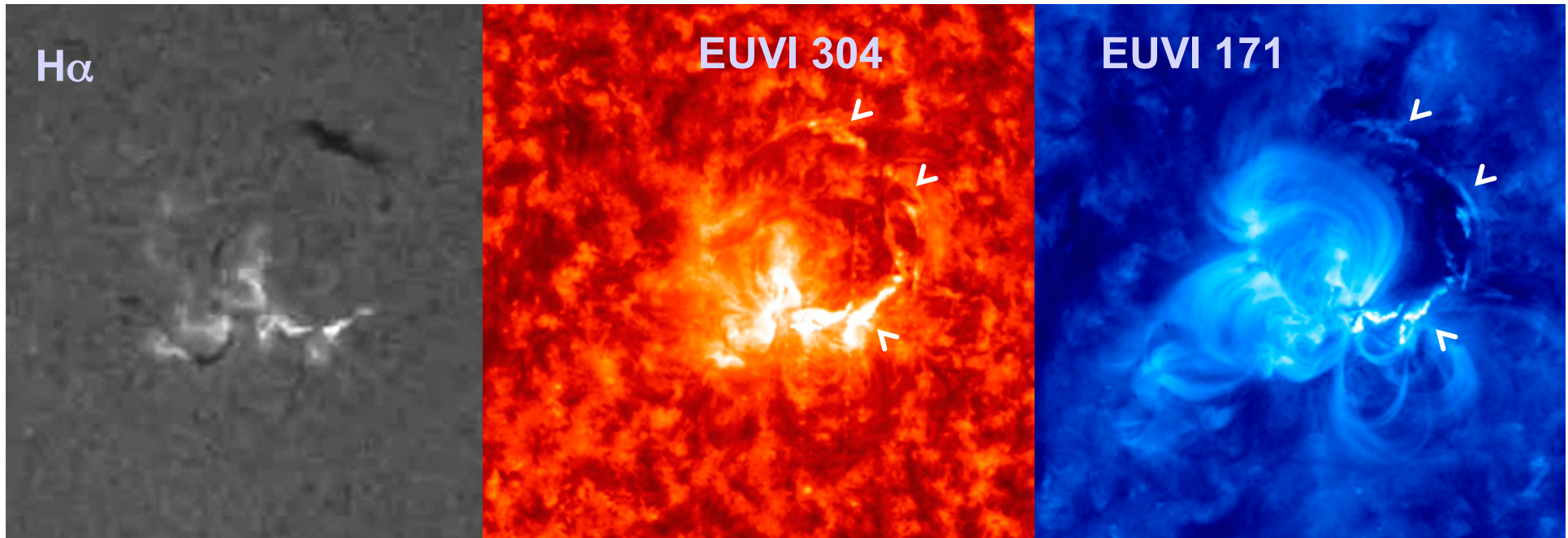
Detailed Pre-eruptions comparison of $H\alpha$ & EUVI 304 at 12:42 UT (6 min prior to eruption)

- “Onset” phase of standard model
- Filament seen to extend much further in He II (304) than $H\alpha$
- EUVI: Heating/surge seen near southern footpoint in AR - Multiple “hot threads”
- $H\alpha$: filament is becoming diffuse and fainter in corresponding region

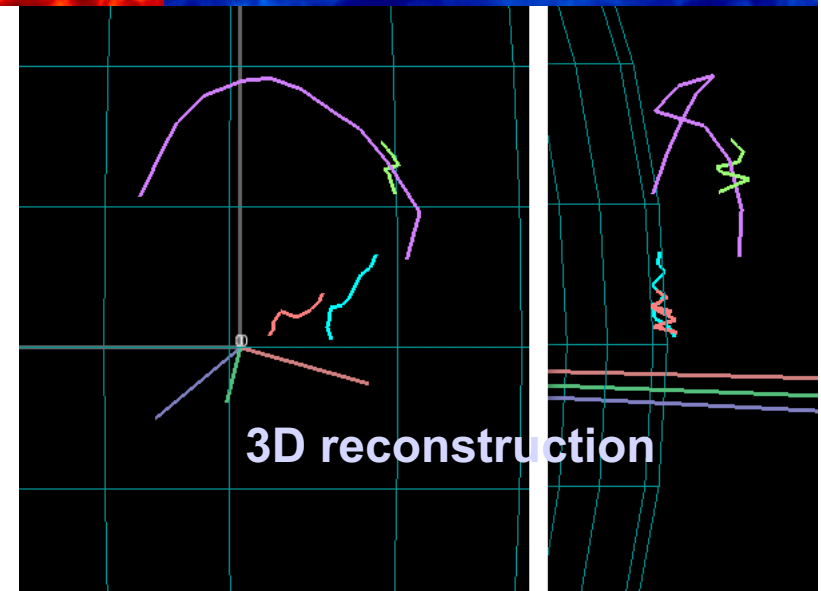


Comparison of $H\alpha$, 304, 171 and 3D during eruption-12:52 UT

12:52: Flare ribbons now easily visible in $H\alpha$ and EUV - “Hot” rising end of filament only visible in EUV but not $H\alpha$ – Indicates **disappearance in $H\alpha$ is due to heating or motion, not depletion**

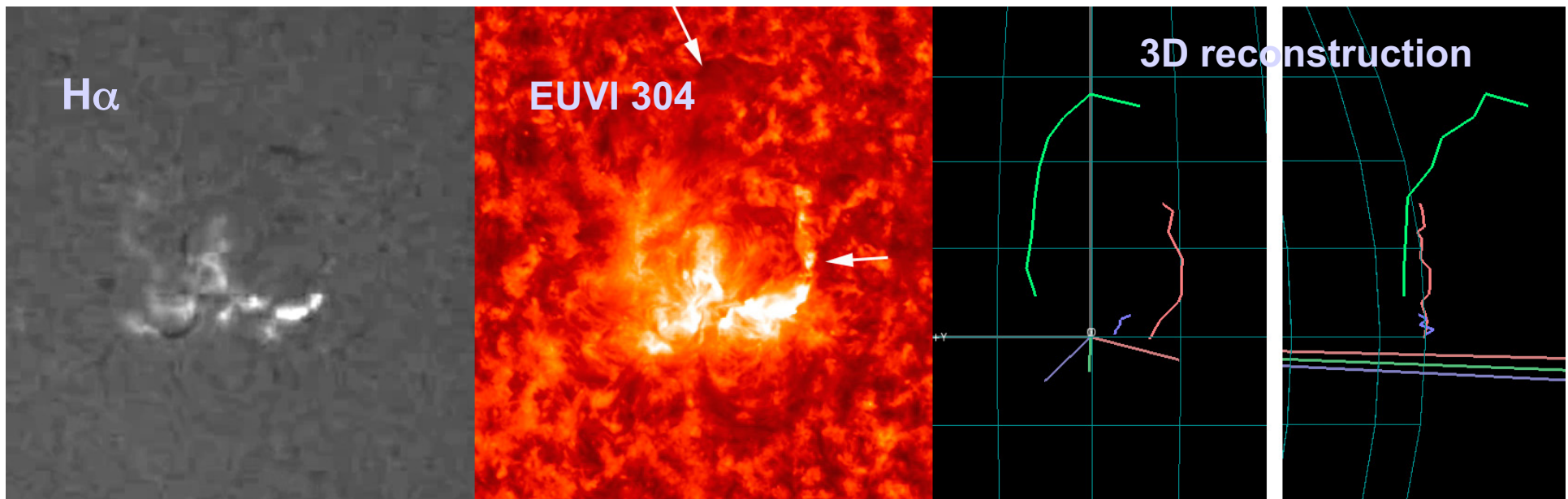


- STEREOscopy shows emissive features at both coronal heights (filament) and at chromospheric heights (ribbons) - only possible with STEREO
- Heating seen both “above” (filament) and “below” (flare ribbons) presumed reconnection point beneath filament
- Single asymmetric filament eruption seen



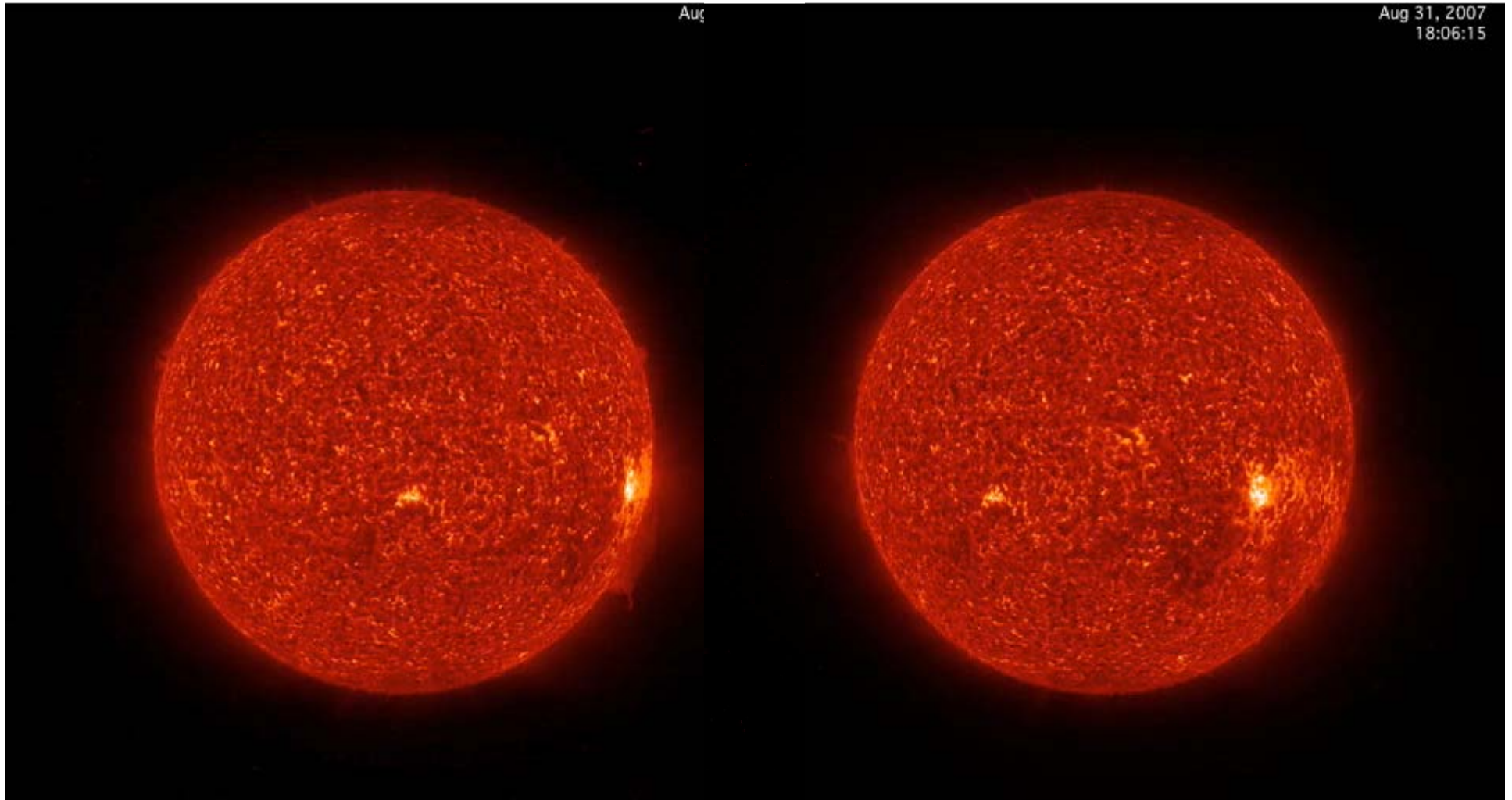
Comparison of $H\alpha$ & He II (304) during Eruption-13:12 UT

13:12 UT During eruption - Filament visible in absorption in 304- but has almost disappeared in $H\alpha$ - Indicates disappearance in $H\alpha$ is due to heating or motion (Doppler shift line out of filter band pass), not depletion



- Green: 304 asymmetric erupting filament (seen in absorption)
- Red & Blue: 304 flare ribbons (seen in emission) at former location of filament in agreement with standard model
- Patchy flare ribbon seen to extend much further in 304 than in $H\alpha$
- STEREOscopy shows features at both coronal heights (dark filament) and at chromospheric heights (ribbons)

STEREO Prominence & CME August 31, 2007

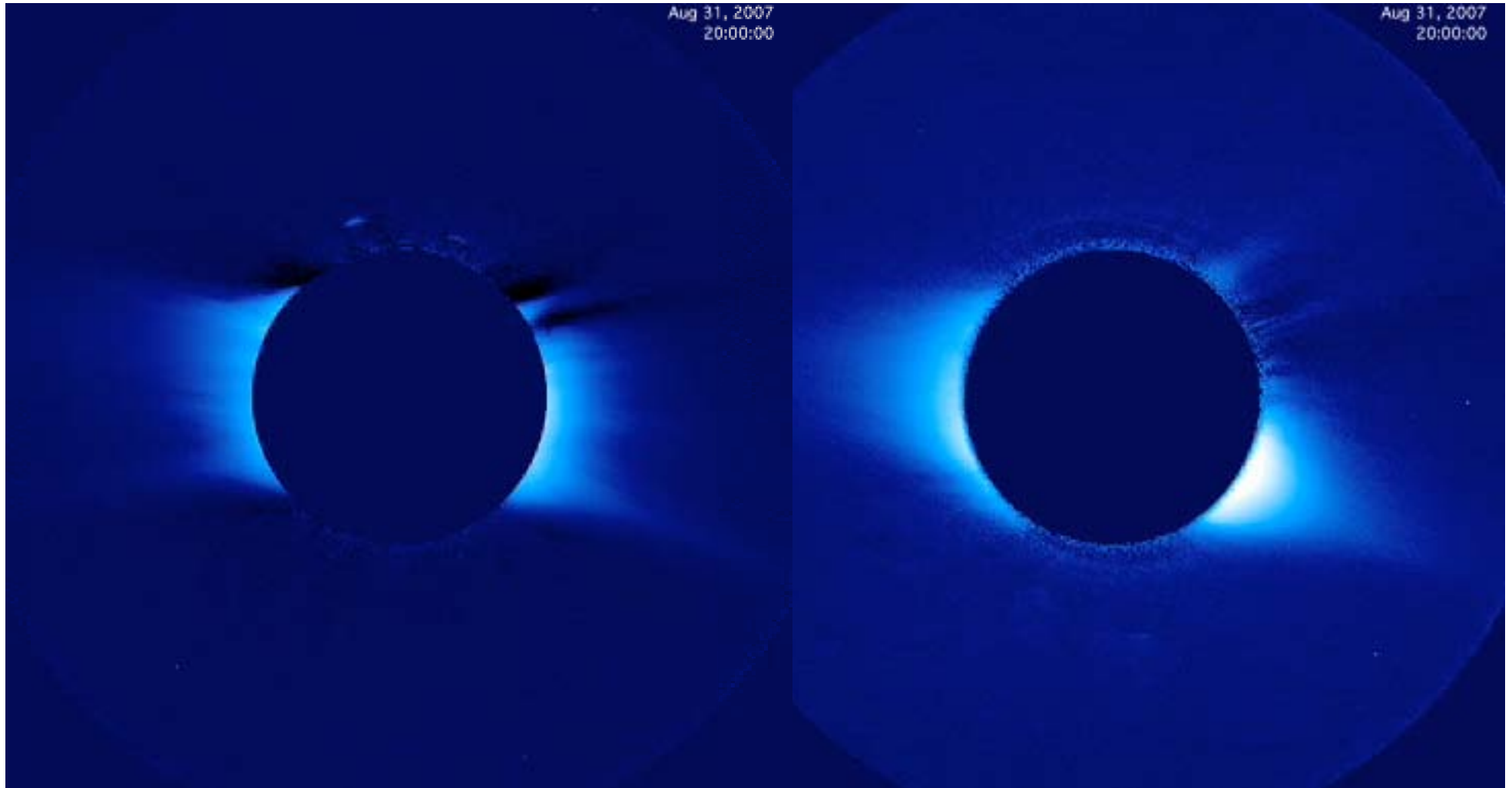


EUVI 304 B

EUVI 304 A

STEREO Prominence & CME August 31, 2007

LASCO data gap: only caught trailing end

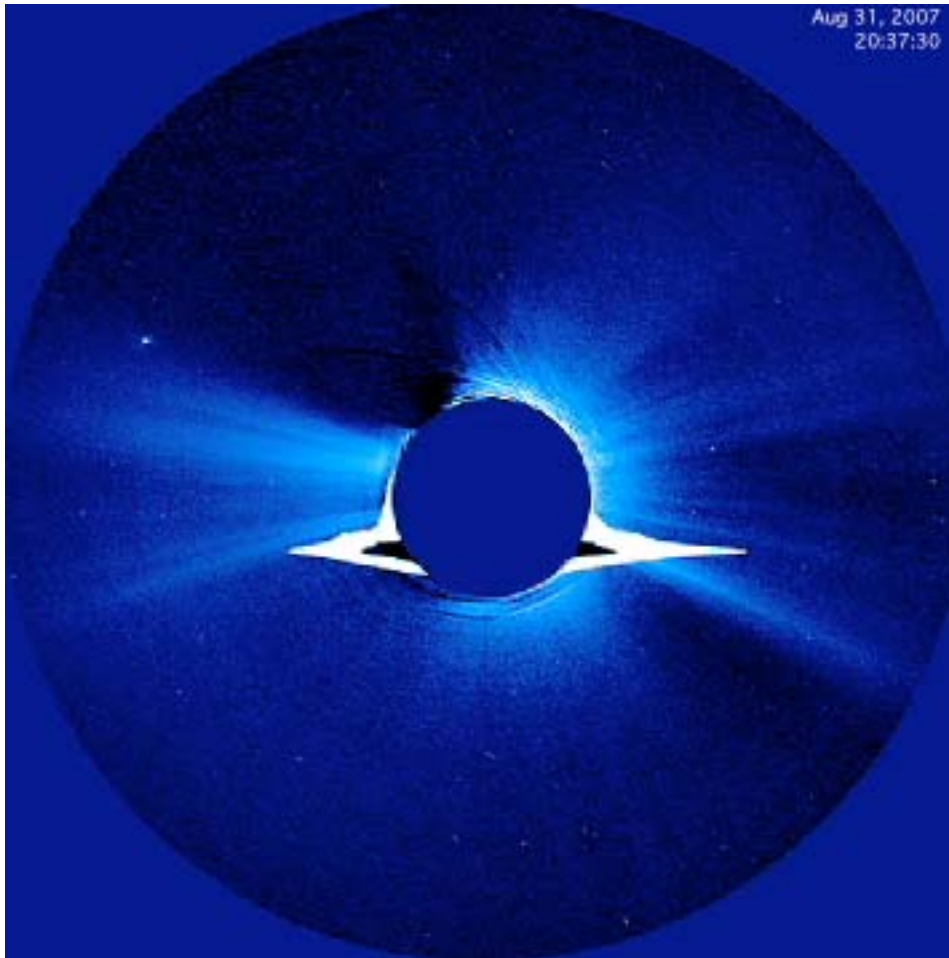


COR1 B

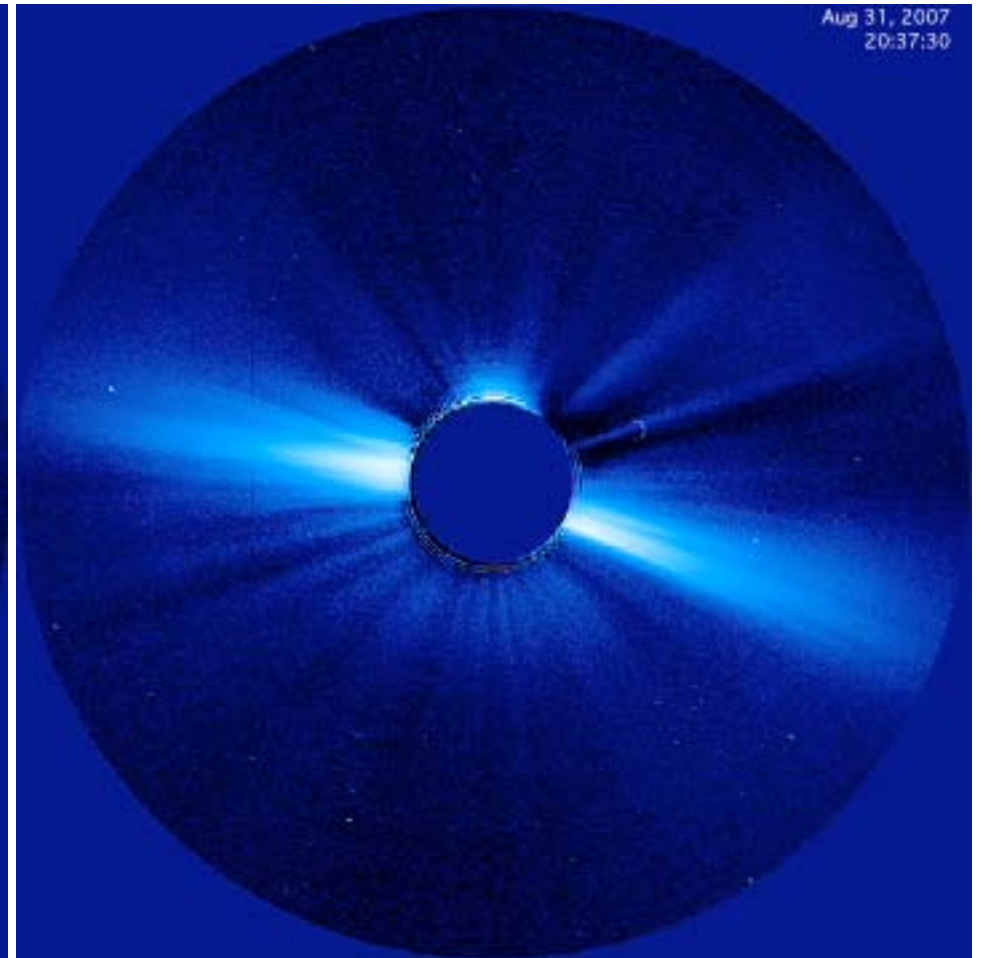
COR1 A

STEREO CME August 31- September 1, 2007

LASCO data gap: only caught trailing end



COR2 B



COR2 A

3D Reconstructions of Prominence + Leading Edges of both Dark Cavity and CME

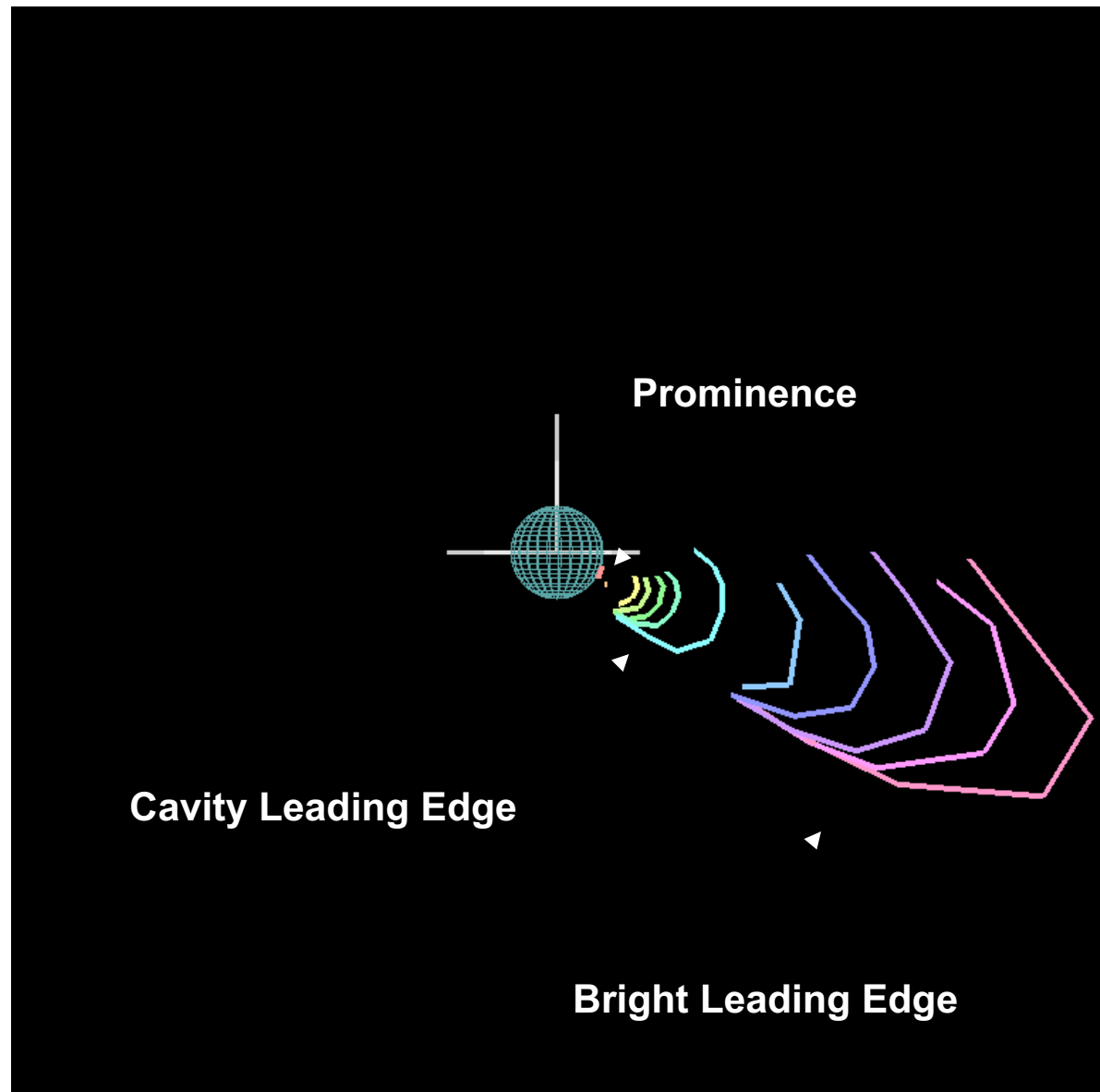
August 31, 2007

EUV 304, COR1,
COR2 data, A + B

Various times
covering 7 hours

Software works
across multiple
FOVs!

20070831_161615 to 20070901_030730



3D Reconstructions of Prominence + Leading Edges of both Dark Cavity and CME

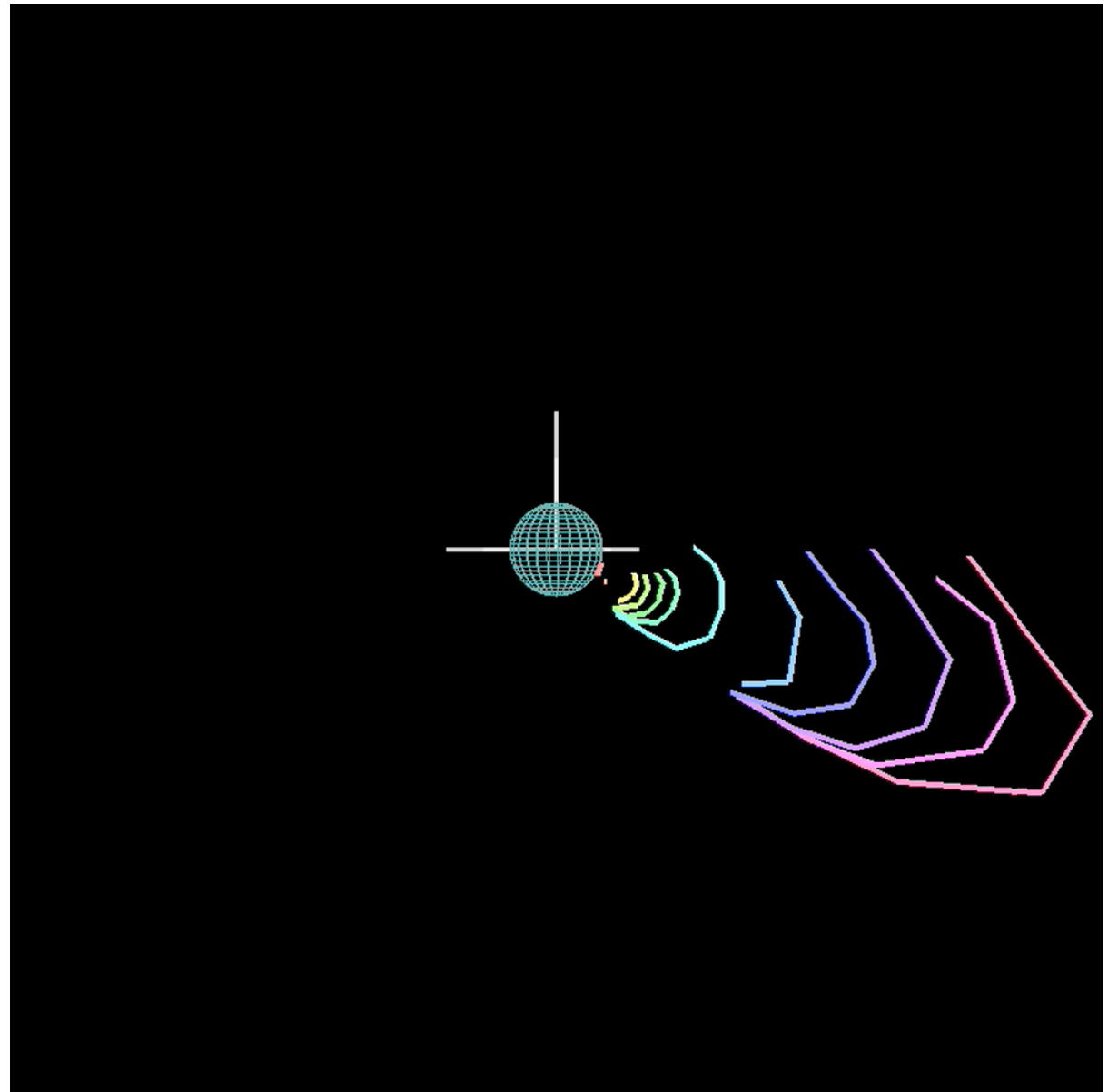
August 31, 2007

EUV 304, COR1,
COR2 data, A + B

Various times
covering 7 hours

Note all line up!

20070831_161615 to 20070901_030730



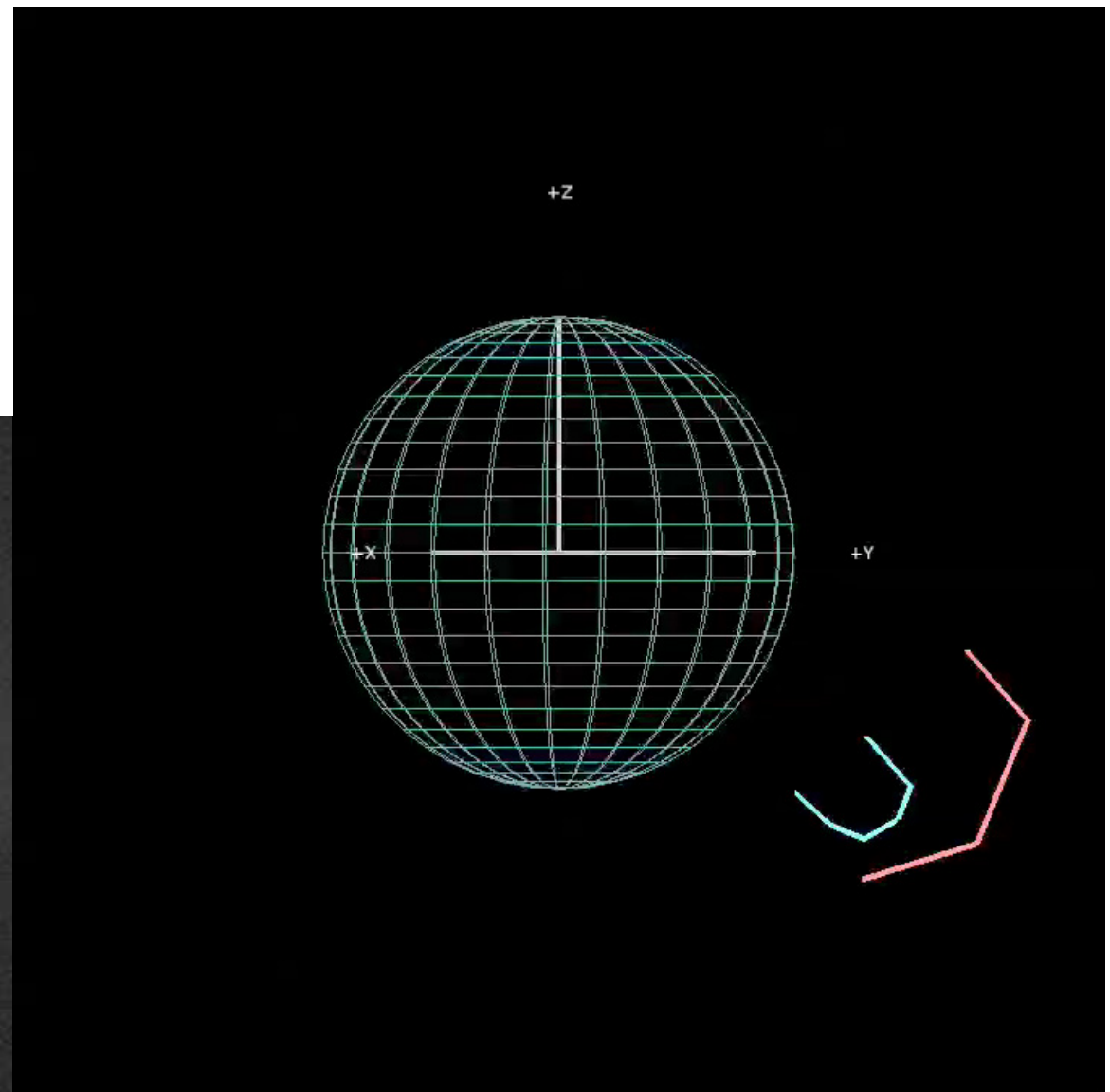
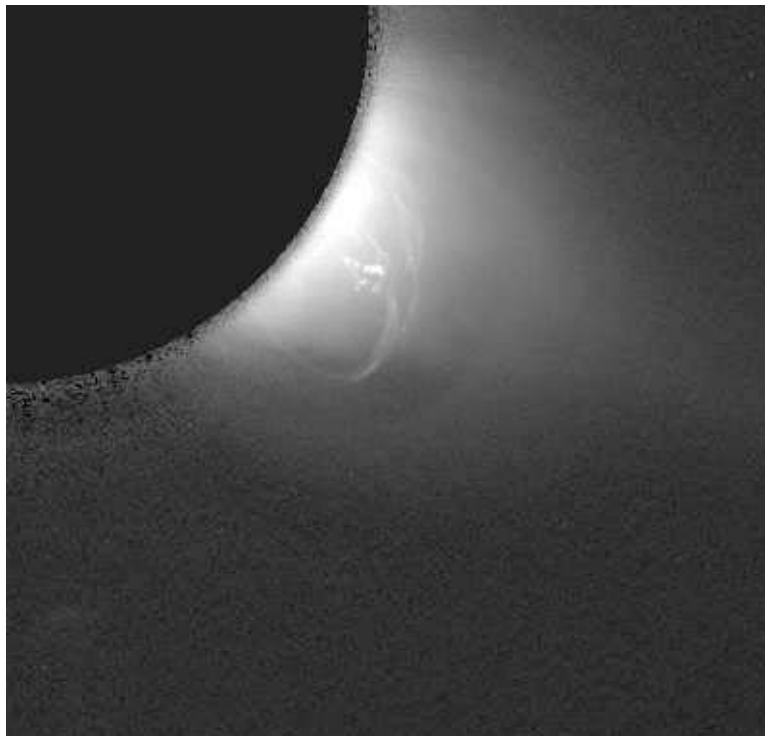
3D Reconstructions of Prominence and Leading Edge of Dark Cavity

August 31, 2007

21:25:00

COR1 A + B

Shows relation of
filament to dark
cavity in 3D



Conclusions

- Results from stereoscopic analysis of SECCHI/EUVI data for 19 May 2007 filament eruption:
 - Determined 3D trajectory of erupting filament
 - Strong evidence for reconnection BELOW erupting filament, consistent with standard model
 - Comparison of EUVI and $H\alpha$ images during eruption indicates disappearance in $H\alpha$ results from heating or motion – not depletion - of filament material
- Results from stereoscopic analysis of 31 August 2007 filament eruption:
 - Can track three features: filament, dark cavity & CME leading edge

